KEY ISSUES AND MANAGEMENT STRATEGIES FOR THE CONSERVATION OF THE HIMALAYAN TERAI FORESTS OF INDIA

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Abstract

The Himalayan Terai forests are the major habitat for a variety of terrestrial biodiversity, with distinct extents of ecosystems, abundance and distribution of species and coverage of protected areas. This lowland region is mainly characterised by tall grasslands, scrub savannah, Sal forests, wetlands, and swamps. The Terai eco-region, shared by India and Nepal, is one of the prominent areas of India from a biodiversity point of view. It is situated along the foothills of the central Himalaya, in the north of the Inda-Gangetic Plain, with a forest covers of ca. 10,000 km² in India. The Terai eco-region contains dense forests, savannas and grasslands, providing critical habitats for many endangered large mammals, including tigers, elephants and rhinoceroses. Currently, the forest of this region is losing its biodiversity because of natural and anthropogenic factors. Because of the high agricultural productivity of the Terai areas, rising aspirations for better living conditions, development activities, industries and road & rail networks, the degradation and fragmentation of these forests have increased in recent years. This paper presents key issues and management strategies for the conservation of the Himalayan Terai forests of India, along with some suggestions to overcome the impacts of natural and anthropogenic disturbances.

Keywords: Natural disturbances; Anthropogenic disturbances; Conservation management; Himalayan Terai

Introduction

India is a land of diversity with twelve biogeographical regions: Trans Himalaya, West Himalaya, East Himalaya, North East India, The Indian Deserts, Semi Arid Zone, Gangetic Plain, Western Ghats, Deccan peninsula, Indian Coasts Andaman and Nicobar Islands and Lakshadweep Islands [1]. The Gangetic Plain is a flat region made up of alluvial soils by Ganga and its tributaries. This geographical region has two types of forests: i) Tropical moist deciduous forests and ii) Tropical dry deciduous forests. The tropical moist deciduous type of forests is present in the Terai eco-region only. Terai inclusively harbours North Indian tropical moist deciduous forest. This is because it is an ecotone between the Gangetic plains and Himalayan foothills, it becomes one of the diverse areas of the country from biodiversity point of view [2-4]. The entire eco-region had unique natural Sal forests and was the home of good

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faunal diversity [5-7]. But now the forest of this region is losing its biodiversity at alarming rate because of natural (floods, global warming) as well as anthropogenic (logging, looping, grazing, agriculture penetration, human settlement) disturbances and therefore, the forest cover has become severely fragmented into some protected forests only [8-11]. These protected forests are either national parks (Rajaji, Jim Corbett, Dudhwa and Valmiki) and wildlife sanctuaries (Kishanpur, Katerniaghat, Suhelwa, Parvati Arga, Bakhira, Sohagi Barwa) or reserve forests (Pilibhit tiger reserve). All these protected forest areas are surrounded by human settlements and even sometimes these settlements are available within the territory of the forests, specifically in the buffer zone [12]. This surrounding human population majorly depends on the forests for several forests products such as wild fruits, root vegetables, mushroom, fodder, firewood and timber [13-16]. Besides these direct services, the forests are also serving the society and environment by some other indirect benefits such as, catchment protection [16-18] flood control [19-22], ground water recharge [23-25], sequestration of ambient carbon [26-29], soil protection and enrichment through nutrients fixing & cycling [30-38] as well as generation of revenue by way of tourism [39]. Hence, the forests of Terai eco-region are very important, not only for the ecological point of view but also for the sociological and economical aspects.

The natural disturbances influence the biodiversity through forest fire, landslides, floods, river banks cutting and extreme weather event, as they alter habitat conditions as well as the population dynamics of forest species [10, 40]. The successional stages and the effectiveness of these disturbances shape the heterogeneity and biodiversity of a forest [41-45]. The Terai forests are intersected by both perennial and seasonal rivers exhibiting seasonal high and low flows. The deposition of sediments by rivers and streams creates several channels within the Terai region with shallow beds. This augments the impacts of periodic floods when monsoon-swollen rivers overflow their low banks and shifts channels. Many areas show high erosion such as gullies that also affect the abundance and distribution of species. Degradation of key watersheds has also led to soil erosion and low water tables that have affected the population dynamics of forest species. The Himalayan Terai eco-region consists of the natural forests as well as a human-dominated landscape with some of the most fertile agricultural lands supporting millions of people dependent on agriculture and natural resources for their livelihoods. Because of the increasing human settlements and economic activities, such as logging, looping, grazing, agriculture intensity, industries and road & rail networks, the degradation and fragmentation of these forests have increased. These factors are triggering the changes in forest structure and dynamics [46, 47]. Midha and Mathur [22] also cite activities such as clear cutting, development of rail and road network, and plantations as the cause of fragmentation of habitats in the Terai ecosystem. This large-scale human interference in the forests actually enhances the effects of such disturbances and their frequency [48, 49]. Anthropogenic activities in many cases cause impacts on the forest health of forests by, reduction in biodiversity, species richness, regeneration percentage and forest community composition [50, 51]. Human activities further accelerate harvesting of useful plants [52-54], lopping plants for fodder [55, 56], uncontrolled grazing [57-59], soil destruction [57, 60], forest fragmentation [61, 62], invasion of alien species [63, 64], loss of native vegetation [65, 66] etc. These are not only the problems of unprotected forests but also of the lawfully declared protected areas by pressure from encroachments, especially near the human settlements [67-69].

The combined effects of natural and anthropogenic perturbations have led an emergent need of implementing restoration and management strategies at regional, national and global level [63, 70-72].

As per Society for Ecological Restoration International, Science and Policy Working Group [73], restoration is a process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. It also helps in the re-introduction and re-establishment of native communities (a group of associated species for a specific area) in their habitats [74]. The enhancement and acceleration of natural processes of forest regeneration for the reestablishment
of healthy forests as well as improvement in the environmental quality are the main objectives of the forests restoration strategies [75, 76]. For a better and feasible restoration management strategy, it is important to study all three main domains viz., social (community structure, benefits sharing, traditional knowledge, empowerment and awareness), ecological (species diversity, site-specific habitats, phytosociological status, environmental condition, causes of threat, resource optimization and approaches of successful history), and economic (economics of the forest, forest produce, ecosystem services, local and national interest, supportive organisation and source of funds required) at local level. The appropriate strategies for restoration and management programmes should be selected and implemented in such a way that the species composition, phytosociological structure, biodiversity, processes and functions of the restored forest all are close to the original forest and be capable to withstand over time [67, 76].

In general, the restoration may include passive protection of remnant vegetation and active acceleration of natural regeneration in a selected forest or other ecosystems [77]. Thus, restoration has two way of action i.e. passive and active. The passive restoration is based on the fact that the forests have high elasticity, resistance and self-repairing capacity which can help them to recover from any kind of disturbances provided they are kept away from further human interferences [76]. However, such a management action/recovery used enough time since these processes are too slow [78]. In this kind of restoration approach, the identification of causal elements is done first. This is followed by elimination or control of these elements to provide sufficient time for self-repairing [79, 80]. Although, it is a natural and well proved safest way of restoration in some areas, in certain conditions (high anthropogenic pressure; low self-repairing capacity due to low seed viability, seedling survival and growth, etc.) this passive way of restoration may not be successful. In such conditions, the active restoration strategies are generally utilised. In this approach of restoration, direct intervention, monitoring and evaluation are used to protect a targeted landscape, specific site, community and/or species. Plantation of native seedlings in scattered way and/or in patches is the most common and simplest way of active restoration [81-83].

The additions of nutrients in the soil, protection of planted seedlings/sapling for survival, judicious protection of disturbed sites are the other ways. Before the selection of any restoration strategy, it is important to know more about the local plants, association and their congregation [84, 85]. Additionally, it is also important to integrate the scientific principles with the community knowledge and its participation to extend the approach of restoration [86]. Keeping all these things in mind the present communication highlights the current key issues in the forest management and restoration and provides suggestions of theoretical and empirical framework for the management and restoration of Terai forest taking the account of local community’s needs and expectations along with the regional changes.

Key issues in forest management and restoration

In the course of this study following issues regarding forest management and restoration have been identified in the Terai region of Uttar Pradesh:

Twenty four species of the total tree species of the region comes under the different categories of IUCN red list and require more attention towards conservation and restoration [4]. Besides these 24 tree species, Indopiptadenia oudhensis (Brandis) Brenan has also been found struggling with against natural and anthropogenic forces for its existence (Fig. 1). It is represented by countable numbers in the Bhabar zone of Suhelwa wildlife sanctuary, Balrampur [11, 87].

The Terai forests are the home of several indigenous species. These species have low ecological amplitude and narrow distribution range, resulting in the risk of their extinction. Although national parks (3 in numbers), wildlife sanctuaries (6 in numbers) and a tiger reserve
have already been declared by the Government, covering an area of about 4,534 km$^2$ [88]; there are large human settlements around the forest and, in many cases, penetrated the protected areas. The encroachment of the forest’s land by the surrounding habitation has been reported since a long time back and the efforts taken so far to encounter these conditions not up to the mark [89-91]. This is the main reason behind illegal logging, lopping, grazing, and agriculture penetration, as well as, for human and wildlife conflicts (Figs. 2 and 3) [92-95].

Fig. 1. Destruction of Indopiptadenia community by riparian damage.

Fig. 2. Forest destruction through: A. Logging; B. Lopping; C and D. Grazing. (D, Ficus squamosa - a grazing indicator tree).

The forests of the entire Terai region including protected areas are also facing the problem of fragmentation due to the presence of roads and railway tracks (Fig. 4). The problem of forest fragmentation by roads and railways and their adverse effects on biodiversity have already been reported from the different parts of the globe [96-102].
Most of the protected areas of the region are situated along the open boundary between India and Nepal and consequently influenced by the trans-boundary lopping and grazing problems (Fig. 5). The entire Terai region is also facing an enormous problem of illegal trade of not only timber wood but also of medicinally important plants, animal and their parts [103, 104]. Lack of awareness and education in the local tribes is another important reason behind the indiscriminate utilisation of forests products.

**Fig. 3.** Illegal penetration of agricultural lands in forest area.

**Fig. 4.** Habitat fragmentation through: A. Road; B. Railway.

**Fig. 5.** Trans-boundary disturbances (logging, lopping and grazing).
Conclusions and recommendations

Based on our own observation together with an extensive survey of literature and other evidences, following suggestions emerge for restoration and management of the forest and species under risk in the region:

As the numbers of plant species are fighting for their existence in the Terai eco-region, there is an urgent need of management programmes for their conservation. For this purpose, the active restoration of species under high risk of extinction through controlling zoo-anthropogenic pressure and accelerating their population growth by seed dispersal, seedling and/or sapling plantation and their monitoring may be adopted [68, 81, 83, 104-113].

As the *Indopiptadenia oudhensis* grows along the river banks on the gravelly-sandy soil, the floods and repairing damages destruct its already shrunken population. There should be some kind of construction or other mechanical support to the river banks to minimize extension of riparian damages. Change in policies such as the declaration of wildlife sanctuaries of the area into national parks may help forest conservation and rehabilitation of human population present within the territory of the protected area. Further development of the road and railways in the area was made only after adequate ecological mapping and the identification of environmentally fragile areas. Ecologically fragile areas should be kept away from habitat fragmentation. The high resolution remote sensing images may also play a very important role in the identification of forest fragmentation as well as the assessment of conservation practices [22, 114, 115].

Large scale trans-boundary lopping and grazing on the Indo-Nepal border need to be prevented and minimized. For this purpose, the responsible authorities from both the countries (India and Nepal) are continuously endeavouring in the direction of awareness generation against illegal trade of timber and non-timber products along with wild floral and faunal diversity among the local people and administrative authorities [104]. Although, several considerable steps have been taken in the direction of biodiversity conservation of the Terai eco-region, but still the illegal trans-boundary trade is a matter of great concern.

Thus there is an urgent need to generate awareness and uplift the education level of tribes living in and around the protected areas. Educating local people would help in understanding the need for sustainable use of forests is for the benefit of society in general and for their future generation in particular.

Acknowledgements

The authors are grateful to Head, Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow; Director, CSIR-National Botanical Research Institute, Lucknow and Head, Department of Botany, Banaras Hindu University, Varanasi for providing necessary facilities. The financial support was received from SERB, DST, New Delhi, India under PDF/2016/002185.

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Received: December 17, 2017
Accepted: November 08, 2018

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